Relativity:

Last class:

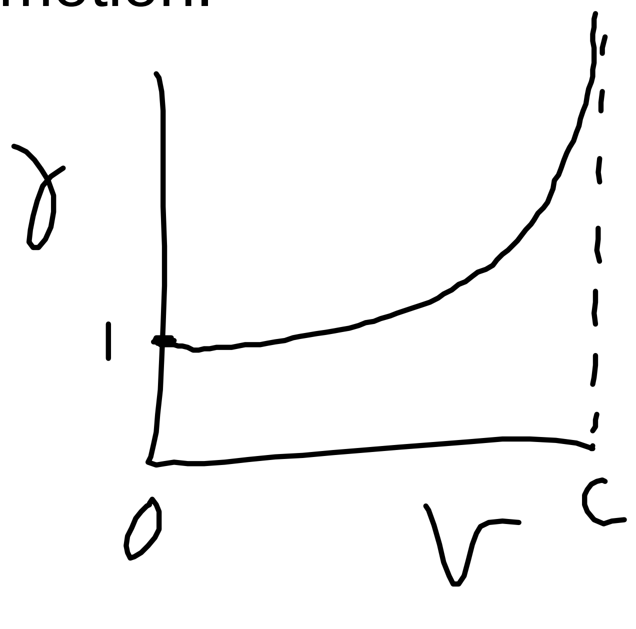
Michelson Morley - tried to detect motion through Ether. Didn't succeed.

Einstein - 2 postulates - 1905

1. Laws of physics are the same in all inertial frames of reference.
2. Speed of light is the same in all frames.

Logically follows:
if the speed of light is the same, but the light goes a different distance when you shift frames, time must be longer with relative motion.

$t=\gamma t_o$ where $\gamma=\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$



since c is an asymptote so nothing can

accelerate to c, regardless of the frame of reference.

Part of the reason is that lengths contract in the direction of motion.

$L=L_o/\gamma$

But where does the energy go? If you do work on a particle, making it go faster but the velocity doesn't increase as much what happens?

One way to look at it is that mass is a form of energy.

$E=mc^2$

$m=\gamma m_o$ where m_o is the "rest mass"

the increased inertia makes it more difficult to accelerate when observed from another frame of reference.

eg. You are in a rocket ship flying to Alpha Centauri 4.5 light years away at 0.99c relative to the Earth. (light year is the distance light travels in a year = cxyear)

a) How long does the return trip take measured by someone on Earth?

b) The person on the rocket ship sees Earth and Alpha Centauri move at 0.99c. What is the distance between them in the rocket's frame?

c) How long is the trip in the rocket's frame?

d) Why is this called the "Twins Paradox"? How do you resolve the paradox?

Handout: Q13,17,24,25

Test next class: optics and relativity (Ch 18, 19 handout)

a) d=vt so t=d/v = 4.5x2/0.99=9.0909 years

- light year/speed of light = 1 year

b) $L=L_o/\gamma$

$$\gamma=\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{1}{\sqrt{1-\frac{(0.99c)^2}{c^2}}}=\frac{1}{\sqrt{1-\frac{0.9801c^2}{c^2}}}=\frac{1}{\sqrt{1-\frac{0.9801}{\square}}}$$

$=\frac{1}{\sqrt{0.0199}}=\frac{1}{0.14106}=7.09$

note gamma has no units, it is a ratio

L=9light years/7.09

9/7.09=1.2694

The round trip is only 1.3 light years for you, on the ship.

L_o is proper length, the distance with no relative motion.

c) t=d/v = 1.2694/0.99=1.2822 1.3years

alternately, you can solve it by time dilation

$t=\gamma t_o$

$9.0909=7.09t_o$

$t_o = 9.0909/7.09=1.2822$

same time! wow 1.3 years.

d) Paradox - logical impossibility (can you go back in time and kill your parents before you were born? - statement "I am lying".

Twin's Paradox - in your frame of reference the clocks on Earth run slow. In Earth's frame of reference, your clocks run slow. This seems to be a paradox.

- solution: simultaneity depends on frame of reference - when now is - events that are simultaneous in one frame of reference, are not in another frame - depending on position and velocity.

So the travelling twin switches space-times when they turn around.

https://www.youtube.com/watch?v=BFLUa0ciMjw